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Research Article

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Effect of different fertility level and micronutrients on nodulation and nutrient uptake by chickpea

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Summary

The field experiment was conducted during *Rabi* season 2013-14 to evaluate the effect of different fertility level and micronutrients on nodulation and nutrient uptake of chickpea (*Cicer arietinum* L.) to fertility levels and micronutrients. Twelve treatments combinations was comprised with three fertility levels -$F_{1:}$40 kg P_2O_5 ha^{-1}, $F_{2:}$60 kg P_2O_5 + 20 kg S ha^{-1} and $F_{3:}$80 kg P_2O_5 + 40 kg S ha^{-1} and four micronutrient levels- $M_{0:}$ control, $M_{1:}$3 kg Zn ha^{-1}, $M_{2:}$0.3 per cent B spray ha^{-1} and M_3:3 kg Zn + 0.3 per cent B spray ha^{-1} were laid out in Spilt Plot Design. The maximum growth, yield, nodulation and nutrient uptake were recorded with higher level of fertility application F_3: 80 kg P_2O_5 and 40 kg which was significantly superior over lower level of fertility F_1 and statistically at par with F_2. The minimum response was recorded with the application of lower fertility level F_1 with micronutrient application.

Key words : Chickpea, Fertility level, Micronutrients, Nodulation, Nutrient uptake

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Introduction

Chickpea (*Cicer arietinum* L.) belongs to genus *Cicer,* tribe Cicereae, family Fabaceae, and subfamily Papilionaceae. India is the largest producer of chickpea in the world covering 9.51 million hectare area and producing 8.83 million tonnes of grain with an average productivity of 929 kg ha^{-1}. In Uttar Pradesh chickpea is cultivated on an area of 6.04 lakh hectares with annual production 7.32 lakh tonnes. The average production of this crop in Uttar Pradesh only 1212 kg ha^{-1} (Anonymous, 2013). Legumes are heavy feeder of phosphorus and less responsive to nitrogen because of their capacity to meet their won nitrogen requirement through symbiotic fixation. Phosphate fertilization of chickpea promotes growth and nodulation which enhances yield. Phosphorus important for hardiness to shoot, improves grain quality, regulate the photosynthesis, govern physico-bio-chemical processes and thereby increase nitrogen fixation. Sulphur is an also essential plant nutrient plays a key role in sustaining higher production of pulse crop, required in the formation of protein, vitamins and enzymes and it's a constituent of amino acids, *viz.*, cystine, cystein, and methionine. Besides, it's involved in various metabolic and enzymatic process including photosynthesis, respiration and legume-rhizobium symbiotic nitrogen fixation (Rao *et al.*, 2006). Few studies have been conducted to analyse the application of micronutrients to chickpea. Micronutrients play an important role in increasing legume yield through their effects on the plant itself, on the nitrogen-fixing symbiotic process and the effective use of the major and secondary nutrients,

resulting in high legume yields. The magnitude of yield losses due to nutrient deficiency also varies among the nutrients (Ali *et al*., 2002). Zinc is active element in biochemical processes and has a chemical and biological interaction with some other elements. Zinc deficiency decreases plant growth by increasing the concentration of boron in the young leaves and tips of the branches. Zn deficiency decreases crop yield and delays crop maturity and also reduces nodulation and nitrogen fixation (Ahalawat *et al*., 2007), which contributes to a decrease in crop yield. In comparison with others crops, the response of the crop to the application of boron is higher in chickpea than in some cereals. Boron directly and indirectly involved in many plant metabolic functions. The application of B is important, when the concentration of B in the soil is less than 0.3 mg kg^{-1} (Ahalawat *et al*., 2007). The foliar spray of boron was found to be beneficial in stimulating plant growth and in increasing yield of crops. B deficiency also causes flower drop and subsequently poor podding of chickpea and poor yields. Therefore, the present investigation was under taken to evaluate the effect of fertility levels and micronutrients on growth, nodulation and nutrient uptake by the chickpea crop.

Resource and Research Methods

The field experiment was conducted at Instructional Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during *Rabi* season 2013-14 to evaluate the effect of different fertility level and micronutrients on nodulation and nutrient uptake of chickpea response of chickpea crop. Twelve treatments combinations *viz.*, three fertility levels -$F_{1:}$40 kg P_2O_5 ha^{-1}, $F_{2:}$60 kg P_2O_5 + 20 kg S ha^{-1} and F_3:80 kg P_2O_5 + 40 kg S ha^{-1} and four micronutrient levels- M_0:control, M_1:3 kg Zn ha^{-1}, M_2:0.3 per cent B spray ha^{-1} and M_3:3 kg Zn + 0.3 per cent B spray ha^{-1} were tested in Spilt Plot Design. Each treatment was replicated three times. The chickpea variety Awarodhi was taken as a test crop. The experimental soil had pH (1:2.5) 8.25, EC 0.35 dSm^{-1}, organic carbon 3.60 g kg^{-1}, available nitrogen 195.20, P_2O_5 18.80, K_2O 240, S 13.20 kg ha^{-1}, Zn 0.49 and boron 0.39 mg kg^{-1}. All the nutrients were applied as basal except boron, for which was applied as foliar. Nitrogen, phosphorus, potassium, sulphur, zinc and boron were applied through urea, diammonium sulphate, elemental sulphur and zinc oxide, respectively. Boron was applied through borax in solution form. For initial characterization of soil, one composite sample was collected and analyzed at the start of the experiment. To assess the various treatment effects, soil sample were collected after harvest of the crop from each plots. Soil pH and EC were determined by following Chopra and Kanwar (1991). Soil organic carbon was determined by Walkley and Black (1934) rapid titration procedure as outlined by Jackson (1973). Soil available nitrogen was determined following Subbiah and Asija (1956). Available phosphorus was determined by Olsen *et al.* (1956) method. Available potassium was determined by following Jackson (1973), while available sulphur was assayed turbidimetrically following method of Chesnin and Yien (1951). DTPA extractable Zn was determined following Lindsay and Norvell (1978). Available boron was determined by hot water method Jackson (1973).

Plant samples were collected from each plot, cleaned, oven-dried at 60^0C and ground in a steel grinder. Extract was prepared by digesting the samples with di-acid mixture (Jackson, 1973). Total P, S, Zn and boron were determined following standard methods.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Plant growth and yield :

Tremendous impact of fertility level on plant height was observed (Table 1). Maximum increment in plant height (53.54 cm) was recorded with the application of higher fertility level F_3: 80 kg P_2O_5 and 40 kg S ha^{-1} which was at par with F_2: 60 kg P_2O_5 and 20 kg S ha^{-1}. The significant impact of micronutrients on plant height was also observed irrespective of soil fertility level. Maximum plant height (53.10cm) was recorded with combined application of micronutrients M_3: Zn 3 kg + boron 0.3 per cent whereas the lowest (46.32cm) was recorded in the micronutrient control M_0. Similar findings were also reported by Patel *et al.* (2013) and Lal *et al.* (2014).

The increase in crop growth has translated into significant improvement in grain and straw yield as recorded with increase in soil fertility level from F_1 to F_3 (Table 1). Phosphorus and sulphur have a critical role to play in terms of nitrogen nutrition (through biological nitrogen fixation) and protein synthesis as well as assimilation, respectively. The experimental soil, being

deficient in available phosphorus and sulphur, responded significantly to increasing level of soil fertility, build-up through addition of P, S and Zn. These findings are in close conformity with the findings of Patel *et al.* (2013); Neenu *et al.* (2014) and Singh *et al.* (2014). Sole and combined application of micronutrients imparted significant boost in grain and straw yield over micronutrient control. The application of Zn + B was significantly better in improvement of grain and straw yield over application of boron and control. In general, combined application of the micronutrient was found to be more effective over their sole application in terms of crop yield. Maximum yield (grain 22.22 and straw 36.01 qha^{-1}) was recorded with combined application M_3. This is perhaps due to better uptake and assimilation of available nutrient by the plant during the entire grand growth period. These results corroborate with the findings of Neenu *et al.* (2014) and Singh *et al.* (2014).

Nodulation :

Increase in soil fertility level had significant positive impact on number, fresh and dry weight of nodule recorded per plant, the maximum being 16.97, 650 and 144 mg, respectively under F_3: 80 kg P_2O_5 and 40 kg S ha^{-1} (Table 1). Phosphorus perhaps plays a key role in this regard although the effects of S and Zn also cannot

Table 1: Effect of fertility levels and micronutrient on plant height, nodulation and yield of chickpea crop

Treatments	Plant height (cm)	Number of nodules $plant^{-1}$	Fresh weight of nodule (mg)	Dry weight of nodule (mg)	Yield (q ha^{-1})	
					Grain	Straw
Fertility levels						
F_1	46.24	14.56	615.00	110.00	18.55	31.08
F_2	51.28	15.13	643.67	135.00	20.89	35.52
F_3	53.54	16.97	650.00	144.00	21.78	36.99
S.E.±	0.63	0.36	11.00	8.01	0.41	0.50
C.D. (P= 0.05)	1.82	1.06	31.00	23.97	1.22	1.56
Micronutrients						
M_0	46.32	14.53	602.00	100.00	18.51	29.80
M_1	51.62	16.08	640.00	132.00	21.97	35.50
M_2	46.86	14.87	616.00	110.00	18.93	30.19
M_3	53.10	16.68	649.00	142.00	22.22	36.01
S.E.±	0.92	0.33	10.10	7.09	0.39	0.41
C.D. (P= 0.05)	2.66	0.98	29.10	21.03	1.17	1.20

Table 2: Effect of fertility levels and micronutrient on nutrients uptake by chickpea crop

Treatments	Phosphorus uptake (kg ha^{-1})		Sulphur uptake (kg ha^{-1})		Zinc uptake (kg ha^{-1})		Boron uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Fertility levels								
F_1	7.65	2.32	6.66	5.29	0.05	0.07	0.060	0.039
F_2	9.51	3.45	7.12	5.98	0.08	0.09	0.070	0.047
F_3	9.91	3.66	7.86	6.03	0.08	0.10	0.074	0.051
S.E.±	0.36	0.14	0.22	0.36	0.003	0.003	0.007	0.004
C.D. (P= 0.05)	1.14	0.39	0.64	1.14	0.01	0.01	NS	NS
Micronutrients								
M_0	7.65	2.54	5.68	4.31	0.06	0.07	0.53	0.39
M_1	9.86	3.71	8.31	6.36	0.08	0.10	0.061	0.039
M_2	8.18	2.58	6.28	4.62	0.06	0.08	0.075	0.048
M_3	10.04	3.75	8.58	6.71	0.08	0.10	0.086	0.057
S.E.±	0.21	0.07	0.20	0.16	0.003	0.003	0.005	0.003
C.D.(P= 0.05)	0.62	0.21	0.57	0.47	0.01	0.01	0.013	0.01

be overlooked. An increase in phosphorus level promotes growth of lateral and fibrous roots thereby facilitating better nodulation. Significant improvement in number, fresh and dry weight of nodules was also observed owing to application of Zn and B either alone or in combination. Among the sole application, Zn contributed significantly in increasing the number and weight (fresh and dry) of nodule over control to the tune of 1.55, (38 and 32g), respectively which was greater than the increment owing to application of Zn and B. Over all, maximum number (16.68) and weight (fresh 649 and dry 142 mg) was recorded with combined application of Z and B (M_3). The increases in better growth characters might be due to application of Zn improve the leg haemoglobin content in root and ultimate increase the weight of root nodules in pulse. These finding also confirms with results of Mishra *et al.* (2002).

Nutrient uptake :

Application of F_3: 80 kg P_2O_5 and 40 kg S ha^{-1} significantly increased the phosphorus uptake in seed and straw over F_1: 40 kg P_2O_5 ha^{-1} which at par with F_2: 60 kg P_2O_5 and 20 kg S ha^{-1}. The application of phosphorus increases the concentration of phosphorus in seed and straw, while application of sulphur as elemental sulphur resulted in increase in availability of phosphorus by improving the soil properties (Neenu *et al.*, 2014 and Sasode and Patil, 2003). Application of F_3: 80 kg P_2O_5 and 40 kg S ha^{-1} had significant effect on sulphur uptake in grain and straw over F_2 and $F_{1,}$ however, no significant difference has been found in respect of boron uptake by grain and straw It might be due to increase in availability phosphorus and sulphur in soil. These results also confirm with the finding of Sharma and Jain (2012). Application of F_3: 80 kg P_2O_5 and 40 kg S ha^{-1} had significant effect on zinc uptake in grain and straw which was at par with F_2: 60 kg P_2O_5 and 20 kg S ha^{-1}. It might be due to increase in zinc availability after application of phosphorus and sulphur in soil. These results confirm the finding of Sharma and Jain (2012).

Application of Zn and B either alone or in combination also enhanced the nutrient uptake by grain and straw over control. Combined application of micronutrients were, however, invariably better than their sole applications. Highest nutrient uptake in grain (P 10.04, S 8.58 and Zn 0.08 kg ha^{-1}) and straw (P 3.75, S 6.71 and Zn 0.10 kg ha^{-1}) was recorded with M_3: 3 kg Zn and 0.3 per cent boron ha^{-1}, which was significantly superior with M_0:Control and at par with M_1. However, maximum boron uptake by grain and straw was observed with the M_3 and minimum with M_0: Control. Pulse crops, especially those growing on inherently nitrogen deficient soils, have to depend heavily upon acquisition of atmospheric nitrogen for meeting their own nitrogen need. It is, therefore, imperative to harness maximum atmospheric nitrogen through fixation by symbiotic microbes by creating congenial and favourable condition for their efficient performance. Boron has been applied to enhance the translocation sugar synthesised in leaves to the roots and nodule to be used as source of energy by symbiotic microbes. Similar results were also observed by Sharma *et al.* (2014) and Kharol *et al.* (2014).

Conclusion :

The present study recorded 12.61 per cent increment in yield of chickpea due to increase application of major nutrients with concomitant increase in their uptake. Better yield and nutrient uptake response of chickpea at higher level of soil fertility reaffirmed the need for proper nutrient management, especially in areas with multiple nutrient deficiencies. Micronutrients application at any level of major soil nutrients, augmented nodulation and nutrient uptake by chickpea, indicating the hunger of plant nutrients. Application of 60 kg P_2O_5 and 20 kg S ha^{-1} along with 3 kg Zn ha^{-1} as basal was more effective to increase in growth, yield, nodulation and nutrient uptake by chickpea crop.

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